CLAIMS

1. A process for compressing input digital video signals and for decompressing compressed binary signals resulting from such a compression, said input digital video signals having at least a luminance component and being formed by a succession of corresponding frames, each representing a video picture and formed by a succession of pixels,

- whereas this compression process consists in looking for the displacements and the sudden modifications in the different corresponding pixels, between two successive frames of the input digital video signals to be encoded, and consisting in deducting from the said displacements and from the said sudden modifications, an encoded signals which comprises, for the initial sequence and for each following sequence of the digital signals beginning with a modification in the video picture represented by the said digital video signals, in a given frame with respect to the previous frame,

on the one hand, at the beginning of sequence, as well as for the pixels suddenly modified in value, at least the said frame or the said pixels of the said digital signals to be encoded, without any modification, and

on the other hand, throughout the sequence up to the beginning of the following sequence, a succession of correction bit packets,

said compression process including:

- a preliminary encoding operation of the said input digital video signals using a wavelet analysis, favouring the transmission of the contours of the successive pictures represented by the said signals, in order to obtain a succession of mosaic encoded digital signals encoding the said signals in the form of a succession of picture mosaics,

- an encoding operation for producing a flow of binary signals from the succession of mosaic encoded digital signals,

- a compression operation of the flow of binary signals in order to produce compressed binary signals as to reduce the number of the binary signals by suppression of the majority of the binary signals of the said flow whose value is

determined within both possible values of such signals, and

• whereas this decompression process consists in decompressing digital signals composed of the compressed binary signals resulting from the said compression process, i.e. comprising for each sequence at least a first digital signals frame, not modified by the said compression process, followed by a succession of correction bit packets,

said decompression process including:

- a decompression operation of the said compressed binary signals which reconstructs the said flow of binary signals before suppression, in the said compression operation, of the majority of binary signals of determined value,

- a decoding operation of the said flow of binary signals producing a succession of mosaic encoded digital signals,

- a final decoding operation reconstructing, from a succession of picture mosaic encoded type signals, a digital video signals formed by a succession of frames, each made of a succession of pixels,

characterised in that

• as the compression process is concerned, it comprises, moreover, at least as regards the luminance component, an additional encoding operation, applied to the succession of picture mosaic encoded digital signals resulting from the preliminary encoding operation, which is sensitive to the displacements of the contours in the said successive pictures and which consists, for each pixel of a frame, said additional encoding operation using:

a) deduction from the said succession of mosaic encoded digital signals of the correction bit packets as packets of binary signals representative of a global modification or not of the pictures between frames and of a displacement or of a non-displacement of the pixel between the frame involved and the previous frames, as well as of the amplitude and of the oriented direction of the displacement, if any, said deduction being done by subjecting the said preliminary encoded digital signals, one frame at a time:

- to a time-related process, in which for each pixel, the value of the said pixel is compared with its previous correct value, smoothed using a «time constant» which is caused to evolve over the course of time to maximise the smoothing, in order to determine two parameters significant of the time variation of the pixel value, parameters which are variable over the course of time and represented by two digital signals, i.e. a first binary signal *DP*, a first value of which represents a threshold overrun determined by the said variation and a second value the non-overrun of this threshold determined by the said variation, and a second digital signal *CO*, with a limited number of bits, representing the instant value, for the said pixel, of the said time constant,

- to a space-related process of the values, for a given frame, of said both digital signals *DP* and *CO* to determine the moving pixels for which simultaneously the said first signal *DP* exhibits the said first value representing the overrun of the said threshold and the said second signal *CO* varies significantly between neighbouring pixels,

- to a process for deducting, for the said moving pixels, the amplitude and the oriented direction of the displacement,

b) a restoration of the position of the pixel if it has been displaced,

c) a check whether the position-restored pixel in case of displacement is in compliance or in non-compliance with the corresponding pixel of the frame involved,

d) a memorisation of the result of this check, and

e) a transfer for compression operation, either, of the said packet of binary signals representative in case of compliance, or of the picture mosaic encoded signals from the said wavelet filter in case of non-compliance; and

• as the decompression process is concerned, it comprises, moreover, a preliminary decoding operation, which is applied to the said flow of decompressed binary signals, and which,

a) causes initially to circulate over a loop, from an input position on this loop, signals of the said flow of the mosaic type corresponding to a first frame of the

video signals to be reconstructed and resulting from the said decompression operation, whereas the travel duration of the said signals over the said loop is equal to that of a frame of the video signals to be reconstructed, each signals of a frame circulating normally in the loop as long as no modification and no displacement is signalled in the decompressed binary signals,

b) repositions in the said loop, the pixels having undergone a displacement signalled by a group of digital signals representing, in the flow of decompressed binary signals, the amplitude and the oriented direction of the displacement, also resulting from the said decompression operation,

c) replaces the picture mosaic type signals in circulation over the said loop with the new signals of this type as they arrive,

d) extracts for transmission to the final decoding operation, from an output position on this loop located downstream of the said input position, the picture mosaic type signals circulating in the loop, after possible repositioning of the pixels.

2. A process according to claim 1, characterised in that it uses, for the compression and decompression processes,

- the preliminary encoding operation of the succession of the digital video signals into a succession of mosaic encoded digital signals corresponding to the scanning, in each frame, of the Mallat diagram and making up the picture mosaic, using a wavelet filter;

- the compression operation, using a compression-decompression assembly, with an adaptive quantifier, *RCL* type encoder and *CH* encoder, Huffman encoder type, operating in compression,

- the decompression operation, using a compression-decompression assembly, with an adaptive quantifier, *RCL* type encoder and *CH* encoder, Huffman encoder type, operating in decompression,

- the final decoding operation, using a reverse-operation wavelet filter.

SUB C1 3. A process according to claim 1 or 2, characterised in that the said preliminary decoding operation causes the said signals to circulate over a loop

with a travel duration equal to the duration of a frame of this signals, causes the said signals, during its travel over the said loop, to pass through a pixel position matrix the number of whose rows, on the one hand, and the number of whose columns, on the other, is at least equal to 2n+1, while designating by *n* the number of levels quantifying the displacement amplitude, whereby the said signals is injected into the said loop at a central position of the said matrix, in bringing back, after running the said first frame of each sequence, within the said central position, a pixel of the said signals, while moving inside the said matrix, which has moved between the frame involved and the previous frame, in relation to the correction bits packet regarding the said pixel, in order thus to restore the successive frames of the sequences as they were before encoding in the encoding operation, and extracts from the said loop, in a position located downstream, in the running direction, of the said central position, the successive frames thus restored.

4. A process according to any one of the claims 1 to 3, characterised in that the said packet of correction digital signals comprises for each pixel four groups of signals:

- the first consists of a single binary signals whereby one of both possible values of which represents a global modification of the pictures between a frame and the previous frame and the other value a global non-modification, said first one signalling the necessity of global correction or the non-necessity of such a correction,
- the second consists of a single binary signals whereby one of both possible values of which represents a displacement for the pixel and the other value a non-displacement, said second one, and,
- both other two consist of digital signals with a limited number of bits and represent, one the quantified amplitude and the other the quantified oriented direction of the displacement if any.

5. A process according to claim 4, characterised in that the additional encoding operation comprises the steps of:

a) encoding the said digital signals, one pixel at a time, in relation to the value variation of each pixel between the frame processed and the previous frames by implementing for each pixel, a block of four digital signals among which

- the first one, which is a binary signals, represents, by both its possible values, either the necessity of global correction or the non-necessity of such a correction,
- the second one, who is also a binary signals, appears exclusively when the said first signals represents the non-necessity of global correction and it then represents, by both its possible values, either a displacement or a non-displacement, and
- the other two, which are both digital signals with a limited number of bits, appear exclusively when the said first signals represents the non-necessity of correction and they then represent, one the quantified amplitude and the other the quantified oriented direction of the displacement in a zone of the composite frame involved;

b) determine whether the proportion, in each successive frame, of the number of pixels for which the said first binary signals has the value representative of a correction necessity with respect to the total number of pixels in the frame, exceeds a determined percentage; and

c) transmitting, one frame after the other, to the said compression operation:

- if the said percentage is not exceeded, the said block of signals related to the pixel affected,
- if the said percentage is exceeded, the mosaic encoded digital signals generated by the preliminary encoding operation.

SuB C2 6. A process according to any one of the claims 1 to 5, characterised in that the said preliminary decoding operation uses in the said loop a square matrix whose odd number of lines and whose number of columns are respectively smaller than the number of lines and the number of columns of a frame of the video signals to be reconstructed, whereas both these numbers are greater, at least by one unit, than the number of quantification levels of the

said displacement amplitude, and through which circulate the signals from the said decompression operation, and the position of the pixels having been displaced is restored, whereas they are subject in the said matrix to a reverse direction translation whose quantified amplitude and whose quantified oriented direction are specified by the digital values of said both other groups of signals.

7. A device for compressing an input digital video signals having at least a luminance component and formed by a succession of corresponding frames, each representing a video picture and formed by a succession of pixels, as well as for decompressing compressed binary signals in a device of this type, operating in compression,

• whereas this compression and decompression device comprises for the compression:

- at least one preliminary encoding wavelet filter (11) of the said digital video signals performing a wavelet analysis, favouring the transmission of the contours of the successive pictures represented by the said signals, in order to obtain a succession of mosaic encoded digital signals encoding the said signals in the form of a succession of picture mosaics,

- an encoding assembly for producing a flow of binary signals from the succession of mosaic encoded digital signals,

- a compression assembly (13/CP) for compressing the flow of binary signals in order to reduce the number of the binary signals by suppression of the majority of the binary signals of the said flow whose value is determined within both possible values of such signals, and

• whereas this compression and decompression device comprises for the decompression:

- a decompression assembly (13/DP) for decompressing the said compressed binary signals which reconstructs the said flow of binary signals before suppression, in the said compression assembly, of the majority of binary signals of determined value,

- a decoding assembly producing a succession of mosaic encoded digital

signals,

- a final decoding assembly composed of a reverse-operating wavelet filter, which reconstructs, from wavelets representing in the form of picture mosaics, a digital video signals, the said digital video signals,

characterised in that

• for the compression, it comprises, moreover, at least as regards the luminance component in the said input digital video signals, an additional encoding assembly (12 A), whose input (20) is connected to the output (16) of the said wavelet filter (11) and whose output (24) is connected to the input (25) of the said compression assembly (13/CP), whereas this assembly is sensitive to the displacements of the contours in the said successive pictures represented by the said succession of encoded signals with mosaic pictures received at the input and comprising, in order to process each pixel of a frame,

a) means (21) to deduct from the said succession of encoded signals with picture mosaics, a packet of binary signals representative of a displacement or of a non-displacement of the pixel between the frame involved and the previous frames, as well as of the amplitude and of the oriented direction of the displacement, if any, said means being:

- means (21*a*) for a time-related process, in which for each pixel, the value of the said pixel is compared with its previous correct value, smoothed using a «time constant» which is caused to evolve over the course of time to maximise the smoothing, in order to determine two parameters significant of the time variation of the pixel value, parameters which are variable over the course of time and represented by two digital signals, i.e. a first binary signals *DP*, a first value of which represents a threshold overrun determined by the said variation and a second value the non-overrun of this threshold determined by the said variation, and a second digital signals *CO*, with a limited number of bits, representing the instant value, for the said pixel, of the said time constant,

- means (21*b*) for a space-related process of the values, for a given frame, of said both digital signals *DP* and *CO* to determine the moving pixels for which

simultaneously the said first signals *DP* exhibits the said first value representing the overrun of the said threshold and the said second signals *CO* varies significantly between neighbouring pixels, where as both these processes, time-related and space-related, and

- means (21*c*) to deduct, from the said moving pixels, on the one hand, the first value, representative of a displacement, for the said second binary signals and, on the other, the digital values of said both other digital groups among the said four groups of digital signals,

b) means (34) to restore the position of the pixel if it has been displaced,

c) means (39) to check whether the position-restored pixel in case of displacement is in compliance or in non-compliance with the corresponding pixel of the frame involved,

d) means to memorise the result of this check, and

e) means (40) to transfer to the said compression assembly (13/CP) either the said packet of signals representative in case of compliance, or the picture mosaic encoded signals from the said wavelet filter in case of non-compliance; and,

• for the decompression, it comprises, moreover, a preliminary decoding assembly, whose input is connected to the output of the said decompression assembly and whose output is connected to the reverse input of the said wavelet filter, which comprises:

a) a loop (50-51-52) whose input (34c) receives, from the said decompression assembly (13/DP), the said reconstructed flow of binary signals, which starts with a picture mosaic type signals corresponding to a first frame of the video signals to be reconstructed and which circulates in the form of a picture mosaic type signals, whereas the travel duration of the said signals over the said loop is equal to that of a frame of the video signals to be reconstructed,

b) means (70) to reposition, in the said loop, the pixels having undergone a displacement indicated by a group of digital signals which represent, in the said reconstructed flow of digital signals, the amplitude and the displacement

direction,
c) means (203) to replace the picture mosaic type signals in circulation in the loop with the new signals of this type as they arrive, and
d) means to transmit to the final decoding operation, from an output (35) located downstream of the said input position, the picture mosaic type signals circulating in the loop, after possible repositioning.

8. A device according to claim 7, characterised in that, for the decompression, the said preliminary decoding assembly comprises:
- means to cause to circulate normally, in a loop (50-51-52), a frame of the said decompressed signals, but encoded, received from the said decompression portion of the said compression-decompression assembly as long as both binary signals represent simultaneously an absence of correction and an absence of movement,
- means to replace, in the said loop, the frame in circulation, with a new frame arriving with new pixel values, in case when the binary correction signals indicates the necessity of a correction,
- means to perform, in a square matrix (50), whose odd number of lines and of columns is smaller than the number of lines and of columns of a frame, whereas both these numbers are greater than, by at least one unit, the number of quantification levels of the said displacement amplitude, and through which circulate the said decompressed signals, a translation operation of the moving pixels within the said matrix from their position to the centre position of pixel in the said matrix, in case when the said first binary correction signals indicates an absence of correction while the said second binary displacement signals indicates a displacement.

SUB C3 9. A device according to claim 7 or 8, characterised it comprises means (203) to cause the said digital signal encoded at the input to circulate over a loop (50-51-52), whose travel duration needed by the said signal is equal to the duration of a frame of this signal, means to cause the said signal, during its travel over the said loop, to pass through a pixel position matrix (50) the

number of whose rows, on the one hand, and the number of whose columns, on the other, is at least equal to 2n+1, while designating by *n* the number of levels quantifying the displacement amplitude, whereby the said signal is injected into the said loop at a central position (60) of the said matrix (50), means (70) to bring back, after running the said first frame of each sequence, within the said central position (60) a pixel of the said signal, while moving inside the said matrix, which has moved between the frame involved and the previous frame, in relation to the packet of correction bits regarding the said pixel, in order thus to restore the successive frames of the sequences as they were before encoding in the encoding operation, and means to extract from the said loop, in a position (35) located downstream, in the running direction, of the said central position (60), the successive frames thus restored.

10. A video compression apparatus, comprising:

- a motion analysis stage, comprising circuitry and/or software designed to identify a pixel of a current frame of a video whose contents correspond to a different pixel of a previous frame of the video, and designed to produce a datum coding motion between the pixel of the previous frame and the pixel of the current frame; and
- at least one other video processing stage of circuitry and/or software interconnected with the motion analysis stage to effect compression of the video.

11. The apparatus of claim 10, wherein the motion analysis stage further comprises circuitry and/or software designed to identify a pixel of the current frame whose contents corresponds to the same pixel of the previous frame.

12. The apparatus of claim 11, wherein the corresponding content is identified when a numerical value of the pixel of the current frame differs from the pixel of the previous frame within a threshold tolerance.

13. The apparatus of claim 11, wherein a datum coding the pixel of the current frame whose contents corresponds to the same pixel of the previous frame is entirely zeros.

14. The apparatus of claim 10, wherein the motion analysis stage further comprises circuitry and/or software designed to convey a content of one pixel of the current frame instead of the datum coding motion of the one pixel.

15. The apparatus of claim 14, wherein the one pixel is selected because of a large change in the content of the one pixel.

16. The apparatus of claim 10, wherein the motion is encoded as a spatial displacement between the pixel of the previous frame and the pixel of the current frame.

17. The apparatus of claim 16, wherein the spatial displacement is encoded as a direction and distance.

18. The apparatus of claim 10, further comprising:

a decoder designed to decode motion coding data produced by the motion analysis stage;

a comparator designed to compare the decoded motion generated by the decoder to a representation of input to the motion analysis stage; and

circuitry and/or hardware controlled by the comparator.

19. The apparatus of claim 18, wherein the circuitry controlled by the comparator introduces corrections in a representation of the stored motion stored in the decoder.

20. The apparatus of claim 18, wherein the circuitry controlled by the comparator is designed to increase a compression factor of the apparatus by introducing noise into the compression of the video.

21. The apparatus of claim 18, wherein the circuitry controlled by the comparator suppresses a motion coding datum, and replaces it with a less-encoded datum for a corresponding portion of the video.

22. The apparatus of claim 10, further comprising:

a wavelet coder upstream of the motion analysis stage.

SUBC4 23. The apparatus of claim 10 or 22, further comprising a run-length coder downstream of the motion analysis stage.

24. The apparatus of claim 10, wherein the motion analysis stage analyses a luminance channel of the video.

25. The apparatus of claim 24, wherein chrominance channels of the video are not analysed in the motion analysis stage.

26. The apparatus of claim 24, wherein chrominance channels of the video are compressed based on the analysis of the luminance channel.

27. The apparatus of claim 24, wherein chrominance channels of the video are compressed according to an intensity change during the stage that analyses the luminance channel.

28. Apparatus for processing digitally encoded video, comprising:

one sequential buffer memory of the size of at least one frame plus 2n lines 2n+1 pixels, where n is the maximum amplitude of motion, digitally encodable in the video pixels, in said buffer memory, said memory having only one operational entry port and one operational output port;

means for delivering to said buffer memory, in a sequential mode on said single entry port, successive pixel values of successive frames of said digitally encoded video; and

circuit and/or software for replacing pixel values in a current video frame at least partially stored, in a sequential mode, in said buffer memory, with pixel values from a previous frame at least partially stored, in a sequential mode, in said buffer memory, in compliance with digital control data, representative of the pixel motion, encoded in said buffer memory.